ABSTRACT OF THE DISCLOSURE

Partially frozen fruit or vegetable extract slush, in a fluent physical state, is cast molded into pellets. The slush is permitted to reside in the mold cavities for a sufficient period of time under substantially isothermal conditions to convert to semisolid particles which retain their shape and form upon ejection from the mold cavities. The discrete semisolid pellets are thereafter frozen into rigid solids preparatory for freeze-drying.

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(54) ## FOOD EXTRACT SLUSH MOLDING

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No. OF CLAIMS 12

This invention relates, in general, to a method of subdividing material into small pellet sized particles. The invention is directed to a method for forming pellets of partially frozen fruit and vegetable extracts. More particularly, the invention pertains to a method and apparatus for molding slushed coffee extract into pellets of predetermined uniform size and shape which are then rigidly frozen prior to being freeze-dried.

During the recent past, freeze-dried soluble coffee has attained wide consumer acceptance and has become recognized as a high quality article of commerce.

The cost of producing freeze-dried soluble coffee, compared with the cost of manufacturing spray-dried soluble coffee, is relatively high. However, the pronounced improvements in product quality obtained by the freeze-drying technique has created an ever increasing consumer demand for this premium-type coffee and has, therefore, spurred efforts on the part of manufacturers to effect further improvements and to determine means of lowering processing costs.

The processing step immediately prior to the freeze-drying operation i.e., freezing coffee extract preparatory for freeze-drying, is recognized as being one of the more critical steps in the entire series of operations for producing high quality freeze-dried coffee and has received much attention by scientists, engineers, and others associated with the production thereof.

The manner in which the coffee extract is frozen, prior to dehydration by sublimation, will, to a large extent, determine the quality of the finished product. The freezing techniques have an important bearing on the aroma content, color and uniformity of the finished product. Additionally, the method to which the extract is frozen will influence the porosity, handleability, fines content, and other factors associated with the freeze-drying and the overall production costs.

Elerath, et al (United States Patent No. 3,373,042) have

developed a method for freezing a large quantity of aromatic coffee extract which can be freeze-dried at a more efficient rate than by previously known methods without aroma loss while, at the same time, producing desirable dark-colored soluble coffee.

Their invention is founded on the discovery that an aqueous extract of soluble coffee solids containing coffee aromas can be partially frozen in a first freezing zone wherein the extract is cooled to above its eutectic temperature while being continuously agitated so as to freeze a partial amount of the water in the extract to the extent the extract will retain its shape and form when at rest. During the partial freezing of the extract in the first freezing zone, the aromas, oil, coffee solids, and the water ice crystals are uniformly blended to provide a homogenous slush material for dehydration in the second, final freezing zone.

The partially frozen extract slush, in the first freezing zone has the consistency of a thick sherbet-like material that will retain its shape and form upon standing and yet be sufficiently plastic to be molded or formed into a desired shape. The partially frozen extract is then deposited in a second freezing zone in a form having adequate surface area for effective freeze-drying, and is chilled to a temperature below its eutectic point to completely freeze the extract in said form.

It has been suggested that the partially frozen extract be transferred from the first freezing zone to the second freezing zone by extruding through a die member under sufficient pressure to form an extrudate in the form of a "rope" or multiplicity of "ropes" or "ribbons" which retain their shape and which can be frozen in the second stage freezing zone before or after being cut into short length particles. This method of transferring the slushed extract provides many tangible advantages to the process and product, e.g., a porous surface and a shape which promotes good freeze-drying efficiency and results in a dark-brown colored soluble coffee product having excellent aroma retention, satis-

factory density, and a color similar to that of roasted and ground coffee.

The transfer of the partially frozen extract from a first freezing zone to a second freezing zone by extrusion has not attained substantial commercial acceptance, however, because of the tendency for the ice crystal content of the extract slush to segregate as the slush slowly passes through the unagitated zone of the extruder immediately prior to being extruded through the orifices in the die block.

Additionally, in order to achieve a darker-colored product and to reduce freeze-drying costs, the coffee extract can be converted to a more highly concentrated condition concomitant with the freezing operation in the first freezing zone by a freeze-concentration technique. Although freeze-concentration has the advantage of removing a portion of the water which otherwise would have to be sublimated during freeze-drying, it increases the viscosity of the concentrated coffee extract which thereby imposes additional difficulties to transferring the partially frozen extract by an extrusion method to the second freezing zone.

The ultimate purpose of freezing coffee extract within two refrigeration zones is to be able to shape the frozen material into small discrete particles having a large proportion of surface area necessary for commercially practical freeze-drying operations. By employing this method in lieu of freezing the extract into large slabs, the frozen particles can be formed without the necessity for grinding with the attendant generation of fine particles which, to say the least, detract from the appearance of the freeze-dried product.

Accordingly, there exists a need for a method and apparatus to efficiently and effectively bring about the continuous transfer of partially frozen concentrated coffee extract in the form of a multiplicity of particles or pellets of uniform composition to a second, final freezing zone where the pellets are

rigidly frozen preparatory to being freeze-dried.

Unexpectedly, it has been discovered the above-mentioned problems can be avoided and a satisfactory method of transfer of the partially frozen extract from a first freezing zone to a second freezing zone can be effected by the method and with the apparatus according to the present invention wherein the partially frozen concentrated coffee extract is molded into pellets of predetermined size and shape. The molded pellets, upon being released from the mold and then transferred to the second freezing zone where they are completely frozen into rigid discrete particles adapted for freeze-drying -- a form which facilitates the operation and affords a high quality coffee product. Consequently, the instant invention represents a significant advance in the important commercial processing of coffee extract into a high quality freeze-dried product.

Briefly, this invention comprehends a method and apparatus for molding partially frozen concentrated coffee extract into discrete pellets. The invention is predicated on the discovery that partially frozen concentrated coffee extract has thixotropic rheological properties and under certain conditions of concentration and temperature will be fluent when subjected to agitation and, at rest, is capable of retaining its shape and form.

The essence of the invention resides in adjusting the solids concentration of the extract, the temperature to which it is subjected and the shear forces necessary to put the slush into a fluent physical state wherein it is capable of being poured or smeared into the cavities of a mold. Residence in the mold cavities for a short period of time with substantially all agitation and shear forces removed permits the slush to "relax" and develop into a semisolid of sufficiently firm consistency such that, when ejected from the mold, it has the capability of retaining its shape and form. It is essential to the success of the invention that the ambient temperature conditions be such that the molding

of the extract slush takes place either isothermally or at a depressed temperature.

According to the invention there is provided a method of freezing extract prior to freeze drying, in which partially frozen extract from a first stage freezing operation is molded into shape and form-retaining semisolid pellets, prior to the transfer to a second freezing stage wherein they are frozen to rigid solid pellets.

In a preferred form there is provided a method of converting a partially frozen extract slush comprised of ice crystals and a plastic unfrozen matrix of a water solution of soluble solids to pellets of uniform shape and size which comprises:

(a) subjecting said slush to coincident mixing and shearing forces to uniformly distribute the ice crystals throughout the matrix and converting the slush to a fluent physical state,

(b) molding the fluent slush by casting said slush within mold cavities and permitting the slush to remain in the mold cavities for a period of time and under temperature conditions which permit said slush to revert to a consistency sufficiently firm to retain the molded shape and form after being ejected from the mold cavity, and

(c) ejecting the shape and form retaining slush extract pellet from the mold.

For the process of this invention, partially frozen extract is prepared in a first freezing zone wherein the extract is chilled to a temperature at which it forms a slush which exhibits a thixatropic fluid behavior and, at rest, is capable of retaining its shape and form.

Although the invention will be described as applied to coffee extract, the term "extract" as used herein is intended to include not only coffee extract but also all other extracts of

fruits and vegetables which, when partially frozen, exhibit rheological properties similar to that of coffee extract.

The term "slush" as used in this specification is intended to mean a partially frozen extract in which water in the form of ice is crystallized from the extract and is dispersed throughout a matrix of unfrozen liquid extract which, due to the crystallization of the water, has a higher concentration of soluble solids than that of the original unchilled extract.

The liquid extract may be converted to the slushed or partially frozen state by chilling it to the proper temperature and for the proper length of time by any of the well-known procedures and with conventional equipment. However, since the slushed extract is a mixture of water ice crystals distributed throughout a concentrated soluble solids solution of a matrix, it is preferable that the extract be converted to the slushed form by a continuous procedure and, incident to chilling, agitated to the extent required to maintain the ice crystals uniformly dispersed throughout the matrix. Therefore, a continuous scrapped surface heat exchanger such as that manufactured by the Votator Division of the Chemtrom Company is preferred for converting the extract to the slushed physical condition. Equipment of this, or similar, design constantly agitates the extract as it is being partially frozen and assures excellent homogeneity of the slush composition.

The slush, as formed for the purposes of this invention, is preferably of a thick pasty consistency and may best be described as being in a soft semisolid physical state. The partially frozen extracts of fruits and vegetables form slushes which exhibit thixatropic properties -- i.e., they become fluid when shaken, stirred, or otherwise disturbed and, when permitted to stand, revert back, or set, to a semisolid. It is, therefore, important to the instant invention that the extract be converted to a slush which exhibits these properties; i.e., a slush which is put into

a fluent state by the agitation within the crystallizer of the first freezing zone sufficient to be transferred, as by being pumped through a conduit, but a slush of such character and consistency that it will set to a semisolid which will retain its shape and form when it is permitted to stand. Within present knowledge most, if not all, extracts of fruits and vegetables can be converted to slushes which exhibit thixatropic properties to various degrees. Extract concentration and chilling temperatures are the more important factors to be considered and will be described hereinafter in detail for exemplary embodiments of the invention.

The slush, upon transfer from the crystallizer or first freezing zone is admitted to molding or forming apparatus of which several preferable embodiments are to be described and which are intended for inclusion within the scope of the instant invention. Essentially, the molding or forming apparatus of the invention provides a multiplicity of small cavities into which the fluent slush is cast. The opened-topped cavities are preferably of small pellet size, say about 3/32" in diameter by 1/16" to 1/8" deep. Understandably, the exact size is not critical and is selected primarily to form pellets of a size which are most suitable for freeze-drying operations.

The slushed extract is permitted to stand in the cavities of the molding apparatus for a predetermined length of time and under ambient temperature conditions which maintain the slush at its constant inlet temperature to convert the slush to a semisolid of suitable consistency and one which holds its shape and form upon release from the molding apparatus.

Upon being released, as by inverting the molding apparatus and/or by ejection with a jet of gas, the semisolid pellets are charged to a second or final freezing zone where they are rapidly frozen into hard brittle particles which do not readily adhere to each other and which are then admitted to a freeze-

drying chamber for further processing. The invention, as described above for preparing fruit and vegetable extracts, finds particular application in the preparation of coffee extract for freeze drying. Preferably, the coffee extract is first slightly frozen to a point whereof about 25% to about 30% of the water content forms large ice crystals which may be removed in accordance with known freeze concentration techniques, such as by centrifugation or by passing the partially frozen coffee extract over a foraminous member to remove the ice crystals from the bulk of the partially frozen extract.

The concentrated coffee extract having a coffee soluble solids content ranging from about 20% to about 45% is then partially refrozen in a first chilling or cooling zone which, preferably, is accomplished in a continuous fashion in a scraped-surface type heat exchanger. Chilling should proceed at a rate whereat it requires at least 10 minutes and preferably 15 to 20 minutes to freeze at least 20%, and preferably about 30% to about 60% of the available water to ice crystals.

Sufficient agitation should be effected to uniformly disperse the ice crystals throughout the unfrozen matrix of the slush formed in the first freezing zone. Experience has shown that best results are obtained when the heat content of the extract is diminished by a controlled amount of one to three gram calories per ml. of coffee extract per minute; since it is at this rate of cooling that large ice crystals are formed which assure a desirable dark-colored freeze-dried product.

The apparatus of the invention comprises:

(a) a continuously movable perforated surface;

(b) a slush distributor positioned on one side of the surface to cast slush into the perforations of the surface as the surface travels beneath the distributor;

(c) a back-up plate in slidable contact with the opposed side of the surface to that of the slush distributor

to retain the slush in the perforations for a portion of the travel of said surface past the back-up plate;

(d) pneumatic means for ejecting the molded slush from the perforations at a point in the travel of the surface after the back-up plate.

In one embodiment

(a) the surface is an endless conveyor belt having a plurality of perforations spaced throughout to receive the fluidized slush, said conveyor belt positioned to travel about each of two end pullies thereby effecting a top delivery position of the belt and a bottom return portion of the belt,

(b) the slush distributor is positioned in slidable contact with the top surface of the endless conveyor belt and extends transversely substantially the entire width of said conveyor belt,

(c) the back-up plate is in slidable contact with the top portion of said endless conveyor belt, and

(d) the pneumatic means is in that portion of the belt returning from the top delivery portion of said conveyor belt.

In another embodiment

(a) the surface is a hollow cylinder rotatable about a horizontal axis, and having a plurality of perforations spaced throughout the circumferential wall of the cylinder to receive the fluidized slush,

(b) the slush distributor is positioned in slidable contact with the outer surface of the circumferential wall of the perforated cylinder and extends substantially the entire width of said cylinder,

(c) the back-up plate is in slidable contact with a portion of the interior circumferential surface of said perforated cylinder wall, and

(d) the pneumatic means is mounted inside the cylinder at the lowest point of travel.

In another embodiment

(a) the surface is a horizontal rotatable disc having a multiplicity of perforations spaced throughout to receive the fluidized slush,

(b) the slush distributor is positioned in slidable contact with the top surface of the perforated disc and positioned to extend radially across the disc to cast fluidized slush into the perforations of the disc as the disc rotates beneath the distributor,

(c) the back-up plate is in slidable contact beneath a portion of the perforated disc, and

(d) the pneumatic means for ejecting the molded slush pellets from the perforations is in that portion of the disc just prior to passing beneath the distributor.

Preferably the back-up plate is provided with temperature controlled means for chilling the back-up plate, whereby molding of the partially frozen fruit and vegetable extract is facilitated.

In the accompanying drawings:

Fig. 1 illustrates the first embodiment;

Fig. 2 illustrates the second embodiment; and

Fig. 3 illustrates the third embodiment.

Thus, in the first contemplated form of the apparatus of the invention (Fig. 1), the coffee extract slush is transferred from the continuous heat exchanger (not shown) through a conduit (10) which connects with a distributor assembly (12) which overlays substantially the width of the top section (14A) of a foraminous endless traveling belt (14). The distributor assembly (12) is arranged with a doctor blade (16) at its forward end in the direction of movement of the top section (14A) of the endless conveyor belt (14) for doctoring the fluent slush into the multi-

plicity of small orifices (18) in the belt which is caused to move beneath the distributor. The coffee extract slush is prevented from flowing out of the orifices in the traveling belt by means of a solid flat surfaced backing member (20) by which the top section of the belt is supported and over which the belt slides. The distributor is located in the proximity of one end of the top section of the belt such that, after the coffee extract slush is smeared or doctored into the orifices as the belt moves below the distributor, the top section of the belt moves almost its full length of travel over the backing member as illustrated in Fig. 1. During this period of travel of the top portion of the conveyor belt, the slush has an opportunity to "relax" or "set" into a condition whereof it is capable of retaining its shape and form. Experimental data show that for coffee extract slush having a soluble solids content ranging from about 20 weight per cent to about 45 weight per cent and chilled to from about 30°F. to about 15°F. and having about 20 per cent to about 40 per cent of the water as ice crystals, the time necessary for the slush to set into a shape-retaining condition ranges from about 20 seconds to about 60 seconds. By adjusting the speed of forward travel of the top section of the belt past the distributor, the time interval necessary to "set" the slush before release from the belt can be attained. After that portion of the belt containing the slush embedded in the orifices passes around the drive pulley (22) (at which time the slush is sufficiently firm to remain in the orifices without the need for a support at either end opening of the orifices), the belt proceeds to carry the slush during its return travel beneath a series of jets of air (24) directed downward in a conduit as shown in Figure 1. The velocity of the air jets is adjusted to be sufficient to impinge upon the exposed portion of the slush in the orifice and drive the semi-solid slush from the orifice in a downward direction and into a bath of liquid re-

frigerant (not shown) for conveying to the second and final freezing zone. Alternatively, since the semisolid particles ejected from the conveyor belt are sufficiently firm to retain their form, they can be ejected to a chamber having an upwardly directed or counterflow of chilled air and then be belt transferred to the second freezing zone. In practice, it is contemplated that the apparatus will be located in an area where ambient temperature conditions will be sufficiently low to prevent the slush from melting during its residence in the apparatus but not low enough to rigidly freeze the slush. It is also contemplated that the back-up plate will be provided with temperature control features which will permit chilling the back-up plate to a temperature which facilitates the molding of the slush. The foraminous belt will be constructed of a non-adhering material such as Teflon (trademark) having a thickness of about 1/16" to about 1/4". The orifices in the belt are intended to be about 1/16" in diameter to about 1/4" in diameter. Understandably, these dimensions can be varied by a wide degree without departing from the spirit of the invention.

Those skilled-in-the-art will recognize that apparatus different in physical structure but similar in operating principal, can be constructed to perform the same or similar operations as described above for Fig. 1.

Fig. 2 illustrates an alternate arrangement of apparatus which is the second embodiment and which is particularly adaptable for smaller product quantities of extract pellets than that contemplated for the use of the apparatus illustrated in Fig.1. As shown in Fig. 2, the conduit (10) in which the slush is delivered to the apparatus communicates with the distributor (12) which overlays the length of a cylinder (26) having a perforated surface. The cylinder is caused to revolve beneath the distributor by a variable drive mechanism (not shown) whereby the slush within the distributor is cast into the perforations (18) in the cy-

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linder surface. The interior surface of the drum is in slidable contact with a backing member (20) for that portion of its travel during the time of passing beneath the distributor and until the slush has set. At a point approximately diametrically opposite the introduction of the slush to the perforations in the cylinder, the slush is ejected from the orifices by a series of jets of compressed air (24) downwardly into a bath of liquid refrigerant, such as described in Fig. 1.

Fig. 3 is presented to illustrate a second alternate apparatus assembly contemplated for carrying out the operations of the invention and which is the third embodiment. As shown, a perforated disc (28) receives the slush from the distributor (12) after which the disc passes over a backing plate (20) for a time sufficient to permit the slush to set. The disc then passes beneath a downwardly directed jet of air (24) or other gas emanating from orifices in a conduit. The jet of air impinges against the pellets and they are ejected downwardly to be thereafter admitted to the second freezing zone.

Although all three embodiments described hereinabove have the same general principal of molding operation, it should be noted that the semisolid pellets of slush are ejected from the cavities in the endless belt of Fig. 1 and the cylinder in Fig. 2 from the same opening into which they were cast. This feature permits the orifices in the belt and the agitator to be tapered as shown in Fig. 4 wherein the opening into which the slush is cast is larger than the opening in the belt or cylinder immediately above the backing member. Upon being impinged with jets of gas, the tapered pellets so molded are more readily ejected from the tapered cavities of the traveling belt and the cylinder.

The utility and potential commercial practicality of the invention has been shown from the results of small scale tests of which the following example is illustrative. It should

be understood, however, that the example is merely meant to be illustrative and the invention is not to be limited thereto.

EXAMPLE

A few grams of cylindrical coffee extract pellets was produced by an experimental laboratory molding method to prove the principle of the invention. Semisolid coffee extract at 18°F., partially frozen to the slushed state from 35% coffee solids concentrated roasted coffee extract, was spread into several 3/32" diameter holes drilled through a 1/16" Teflon sheet.

The molding was accomplished under substantially isothermal conditions in a room where the temperature was maintained at 10 - 20°F. After about one minute, the pellets of coffee extract had "relaxed" and set to a sufficiently rigid state whereupon, being ejected by impingement with a stream of nitrogen gas, they maintained their cylindrical shape.

While the foregoing has illustrated and described what is now contemplated to be the best mode of carrying out the invention, the constructions are, of course, subject to modifications without departing from the spirit and scope of the invention. Therefore, it is not desired to restrict the invention to the particular forms of construction illustrated and described, but to cover all modifications that may fall within the scope of the appended claims.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A method of freezing extract prior to freeze drying, in which a partially frozen extract from a first stage freezing operation in the form of a fluent slush is molded by casting said slush within mold cavities and permitting the slush to remain in the mold cavities for a period of time and under temperature conditions which permit said slush to revert to a consistency sufficiently firm to retain the molded shape and form after being ejected from the mold cavity, and the shape and form retaining slush extract pellets are ejected from the mold and the slush extract pellets are charged to a second freezing zone to freeze the pellets to rigid solid pellets.

2. A method according to claim 1, in which the fluent slush is prepared by subjecting a partially frozen extract slush comprised of ice crystals and a plastic unfrozen matrix of a water solution of soluble solids to coincident mixing and shearing forces to uniformly distribute the ice crystals throughout the matrix and converting the slush to a fluent physical state.

3. A method according to either of claims 1 and 2, wherein the partially frozen extract is an extract selected from the group consisting of fruit and vegetable extracts.

4. A method according to either of claims 1 and 2, wherein the partially frozen extract slush is coffee extract slush.

5. A method according to either of claims 1 and 2, wherein the extract is coffee extract and the partially frozen coffee extract slush has a coffee solids content ranging from about 20 to about 45 weight per cent based on the weight of the slush.

6. A method according to either of claims 1 and 2, wherein the extract is coffee extract and wherein the partially frozen coffee extract slush has from 20 to 60 weight per cent ice crystals and 20 to 45 weight per cent coffee solids based on the weight of the slush.

7. A two-stage method of freezing coffee extract prior to freeze drying the extract wherein a partially frozen extract from a first freezing zone is transferred to a second freezing zone, in which:

a) a fluent partially frozen coffee extract slush is prepared consisting of water ice crystals uniformly distributed throughout a plastic matrix of water solution of soluble coffee solids,

b) the fluid slush is molded into semisolid pellets by casting said slush within a multiplicity of open-top mold cavities and permitting the slush to remain quiescently in the mold cavities for a period of time and under substantially isothermal temperature conditions which permit said slush to convert to a consistency sufficiently firm to retain the molded shape and form after being ejected from the mold cavities,

c) the semi-solid pellets are ejected from the mold; and

d) the semi-solid pellets are charged to a second freezing zone where the pellets are rapidly frozen into hard, brittle particles which do not readily adhere to each other and which are then admitted to a freeze-drying chamber for further processing.

8. Apparatus for molding partially frozen fruit and vegetable extracts which comprises:

a) a continuously movable perforated surface;

b) a slush distributor positioned on one side of the surface to cast slush into the perforations of the surface as the surface travels beneath the distributor;

c) a back-up plate in slidable contact with the opposed side of the surface to that of the slush distributor to retain the slush in the perforations for a portion of the travel of said surface past the back-up plate;

d) pneumatic means for ejecting the molded slush from the perforations at a point in the travel of the surface after the back-up plate.

9. Apparatus according to claim 8, wherein:

a) the surface is an endless conveyor belt having a plurality of perforations spaced throughout to receive the fluidized slush, said conveyor belt positioned to travel about each of two end pullies thereby effecting a top delivery position of the belt and a bottom return portion of the belt,

b) the slush distributor is positioned in slidable contact with the top surface of the endless conveyor belt and extends transversely substantially the entire width of said conveyor belt,

c) the back-up plate is in slidable contact with the top portion of said endless conveyor belt, and

d) the pneumatic means is in that portion of the belt returning from the top delivery portion of said conveyor belt.

10. An apparatus according to claim 8, wherein:

a) the surface is a hollow cylinder rotatable about a horizontal axis, and having a plurality of perforations spaced throughout the circumferential wall of the cylinder to receive the fluidized slush,

b) the slush distributor is positioned in slidable contact with the outer surface of the circumferential wall of the perforated cylinder and extends substantially the entire width of said cylinder,

c) the back-up plate is in slidable contact with a portion of the interior circumferential surface of said perforated cylinder wall, and

d) the pneumatic means is mounted inside the cylinder at the lowest point of travel.

11. An apparatus according to claim 8, wherein:

a) the surface is a horizontal rotatable disc having a multiplicity of perforations spaced throughout to receive the fluidized slush,

b) the slush distributor is positioned in slidable contact with the top surface of the perforated disc and positioned to

extend radially across the disc to cast fluidized slush into the perforations of the disc as the disc rotates beneath the distributor,

c) the back-up plate is in slidable contact beneath a portion of the perforated disc, and

d) the pneumatic means for ejecting the molded slush pellets from the perforations is in that portion of the disc just prior to passing beneath the distributor.

12. An apparatus according to any one of claims 9 to 11, wherein the back-up plate is provided with temperature controlled means for chilling the back-up plate, whereby molding of the partial fruit and vegetable extract is facilitated.

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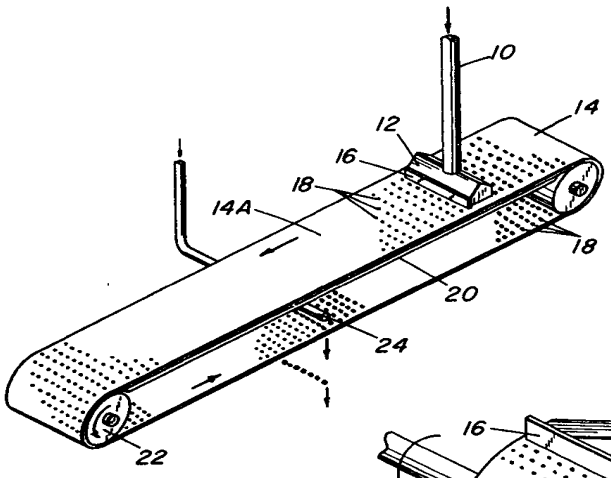

FIG. 1

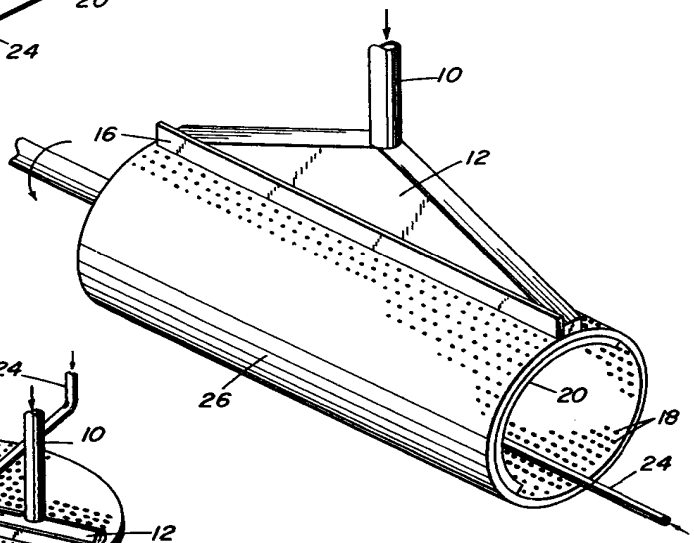

FIG. 2

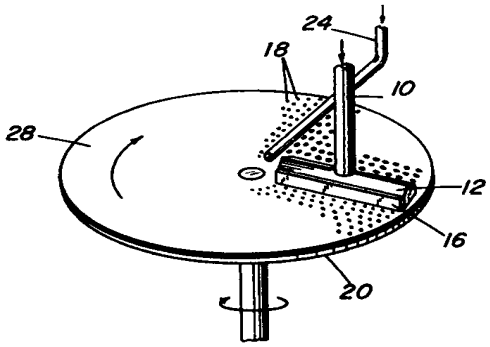

FIG. 3

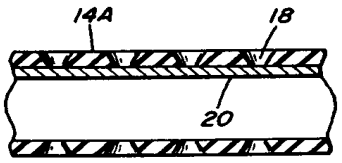

FIG. 4

Gowling & Henderson.